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# Qualification, Demonstration & Validation of Compliant Removers for Aircraft Sealants and Specialty Coatings

**John Stropki and Jim Tankersley, Battelle**

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BUSINESS SENSITIVE

# Presentation Outline

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- Project Overview
- Baseline Analysis
- Requirements Analysis
- Vendor Identification/Selection/Pre-Screening
- Vendor Down-selection
- G-9 Sealants Committee Conference 2007
- Current Status/Ongoing Activities

# Project Team

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- **Air Force**

- Mr. Alan Fletcher, PI (AFRL/MLSA)
- Mr. David Tanner (OC-ALC)
- Mr. Jerome Jenkins (OO-ALC) DEM/VAL at Hill AFB



- **Navy**

- Ms. Diane Kleinschmidt, Navy Lead (NAVAIR)
- Mr. Jack Benfer and Brad Younger  
DEM/VAL at NADEP Jacksonville
- Mr. Don Harmston (NADEP North Island)
- Mr. Jack Fennell (NADEP Cherry Point)



- **Battelle**

- Mr. Jim Tankersley, Program Coordinator
- Mr. John Stropki, DEM/VAL Coordinator



- **UDRI**

- Ms. Susan Saliba/Mr. John Dues, Qualification Testing



# Stakeholders

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- **Primary**

- ALCs
- Navy Depots
- Army
- Vendors
- G-9 (Aerospace sealants committee)

- **Secondary**

- ASC/ENVV (Pollution Prevention Office)
- SPO
- AFCPO (Air Force Corrosion Prevention Office)
- MAJCOMs
- Commercial Aerospace Companies

# Objective and Scope

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## **Objective:**

- To demonstrate and validate performance of COTS environmentally friendly (*contains no TRI chemicals, no HAPs, or chlorinated compounds*) chemical strippers for use on MIL-SPEC sealants and specialty coatings

## **Scope:**

- Determine environmental and economic benefits associated with alternative chemical sealant/coating removal processes and communicate results to an advisory group that includes AF, Army, Navy, and OEMs
- Demonstrate improved removal efficiency, reduced labor and effort, reduced costs, and reduced structural damage to metallic and composite substrates

# Expected DoD Benefits

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- **Pollution Prevention**

- Reduced waste stream
- Reduced treatment of hazardous materials
- Improved worker safety

- **Cost Savings/Avoidance**

- Reduce Disposal Costs of Current Removers by 95%
- Reduce VOC Emissions Costs of Current Removers by 95%
- Reduce Costs of PPE by 95%

- **Improved Removal Process**

- Minimal damage to substrates
- Environmentally benign and compliant substitute
- Minimal PPE
- No Special Facilities
- Improved Removal Rate

# Project Milestones

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1. Baseline Analysis Aug 06
2. Requirements Definition Sep 06
3. Screening Tests Complete/Down-select Dec 06
4. Draft Dem/Val Plan Mar 07
5. Final Dem/Val Plan May 07
6. Qual. Tests Complete/Phase 1 Report Jun 07
7. Dem/Val Complete Aug 07
8. Technology Transfer Plan Sep 07
9. Final Report Dec 07

# Technical Approach

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- **Task 1. Technology Demonstration Plan**
  - Establish stakeholder team
  - Draft technology demonstration plan
- **Task 2. Technology Qualification**
  - Establish qualification test plan
  - Screening tests for strippers supplied by vendors
  - Comprehensive testing for down-selected strippers
- **Task 3. Technology Validation**
  - Demonstration on condemned and serviceable parts
- **Task 4. Technology Transfer**
  - Draft technology transfer plan
  - Assist in writing changes to Tech Orders
  - Establish NSNs for strippers
- **Task 5. Regulatory Data/Support**



# DEM/VAL Locations

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## **Air Force Test Site**

- OO-ALC
  - Aircraft integral fuel tanks (IML)
  - External fuselage (OML)

## **Navy Test Site**

- NADEP JACKSONVILLE
  - Aircraft structures (IML and OML)
  - Selection based on end-user application

Approvals required: Yes

Permits required: None

# Transition Plan

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- Prepare Industry Standard for Removers
- Establish NSNs for Removers
- Add Removers to Tech Orders
  - TO 1-1-3 fuel tank repair
  - TO 1-1-8 coating application
  - TO 1-1-691 cleaning/coating application
- Communication of DEM/VAL Results Across DoD and Industry
  - Quarterly and final reports
  - Preparation of draft Process Order
  - Presentations at conferences and meetings
  - Life-Cycle Cost Analysis
- Approach for obtaining DoD and regulatory acceptance
  - Air Force and Navy Materials Safety Organizations
  - Chemical company chemical registration

# Baseline Analysis Task

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- Survey questionnaires were sent to key Air Force and Navy weapon systems engineers
- Telephone interviews included:
  - Identification of weapon systems
  - Identification of sealants and specialty coatings
  - Validation of current materials, equipment, and processes used to remove sealants and specialty coatings from aircraft structures

# Baseline Analysis Stakeholders

Stakeholder	Affiliation	Survey Respondent
Don Harmston	NADEP NI, CA (Code 4.9.7.4.0)	Yes
Jack Fennell	NADEP CP, NC (Code 4.9.7.4)	Yes
Jack Benfer	NADEP JAX, FL (Mat. Eng. 497)	Yes
Brad Younger	NADEP JAX, FL (Mat. Eng. 497)	Yes
Jerome Jenkins	OO-ALC, UT (309th AMXG/EN)	Yes
Jerry Rhodes	OC-ALC, OK (76 AMXG/MXAPP)	Yes
David Tanner	OC-ALC, OK (76 MXSS/MXDEBB)	Yes
Mark Harris	OC-ALC, OK (76 AMXG/MXAPE)	No
Butch Boutwell	WR-ALC, GA (402 MXG/MXACP)	Yes
James Cranford	WR-ALC, GA (560 AMXS/MXABP)	Yes
Mark Cundiff	WR-ALC, GA (402 AMXG/MXAOPM)	No
Hector Herrera	WR-ALC, GA (402 AMXG/MXAAP)	No

# Baseline Task Summary - Weapon Systems and Sealants (Navy)

Affiliation	Weapon Systems	Sealant/Coatings <sup>[1]</sup>	Primary Removal Methods	Dem/Val Candidates
NADEP NI	F-18, E-2, C-2, S-3	Polysulfide ( <i>all</i> ) Polyurethane ( <i>none</i> ) Polythioether ( <i>F-18</i> ) Sp. Coatings ( <i>all</i> )	- plastic scrapers ( <i>all</i> ) - Scotchbrite® pads ( <i>all</i> ) - solvent ( <i>wipe up</i> )	- wings & access doors ( <i>F-18</i> ) - back shop parts ( <i>all</i> )
NADEP CP	H-46, H-60, H-53, E/D, UH-1, AH-1, AV-8B	Polysulfide ( <i>all</i> ) Polyurethane ( <i>none</i> ) Polythioether ( <i>all</i> ) Sp. Coatings ( <i>all</i> )	- SR-125 softener - plastic scrapers ( <i>all</i> ) - cutters for cup seal	- polythioether on wings ( <i>AV-8B</i> ) - back shop parts ( <i>all</i> ) - boneyard parts ( <i>all</i> )
NADEP JAX	EA-6B, P-3, H-60, E-6, T-45	Polysulfide ( <i>all</i> ) Polyurethane ( <i>none</i> ) Polythioether ( <i>none</i> ) Sp. Coatings ( <i>all</i> )	- Turco 6881 and B&B 5151 softeners ( <i>OML</i> ) - plastic scrapers ( <i>all</i> )	- IML/OML of fuselage, wings, and horizontal stab ( <i>P-3</i> )

<sup>[1]</sup> **Note:** Specialty coatings refers to adhesives, binders, resins, and primers

# Baseline Task Summary - Weapon Systems and Sealants (Air Force)

Affiliation	Weapon Systems	Sealant/Coatings <sup>[1]</sup>	Primary Removal Methods	Dem/Val Candidates
OO-ALC	C-13, F-16, F-22, A-10	<p><b>Polysulfide (C-130 &amp; A-10 only)</b></p> <p>Polyurethane (<i>all</i>)</p> <p>Polythioether (<i>F-16 and F-22 only</i>)</p> <p>Sp. Coatings (<i>all</i>)</p>	<ul style="list-style-type: none"> <li>- Henkel 5351 and B&amp;B 1567/5095 softeners (<i>C-130 IML</i>)</li> <li>- phenolic scrapers, nylon brush, rubber squeegee (<i>C-130, A-10 and F-16</i>)</li> </ul>	<ul style="list-style-type: none"> <li>- wing box fuel cells (<i>F-16</i>)</li> <li>- sloping longerons (<i>C-130</i>)</li> <li>- Composites (<i>F-22</i>)</li> </ul>
OC-ALC	B-52, B-1B, E-3, KC-135	<p><b>Polysulfide (all)</b></p> <p>Polyurethane (<i>none</i>)</p> <p>Polythioether (<i>B-1 only</i>)</p> <p>Sp. Coatings (<i>all</i>)</p>	<ul style="list-style-type: none"> <li>- MPK and MEK softeners (<i>B-52 and KC-135</i>)</li> <li>- plastic and brass scrapers (<i>KC-135</i>)</li> <li>- brass brush and toothbrush (<i>KC- 135</i>)</li> </ul>	<ul style="list-style-type: none"> <li>- IML surfaces of outer wing fuel tank (<i>KC-135</i>)</li> <li>- IML and OML of wing tank (<i>B-52</i>)</li> <li>- Off-aircraft component parts (<i>all</i>)</li> </ul>
WR-ALC	C-5, C-130, F-15	<p><b>Polysulfide (all)</b></p> <p>Polyurethane (<i>F-15</i>)</p> <p>Polythioether (<i>C-5</i>)</p> <p>Sp. Coatings (<i>all</i>)</p>	<ul style="list-style-type: none"> <li>- Pressurized water (<i>F-15 &amp; C-130</i>)</li> <li>- PMB (<i>F-15 only</i>)</li> <li>- Brass brushes and scrapers (<i>C-130</i>)</li> <li>- plastic scrapers (<i>all</i>)</li> </ul>	<ul style="list-style-type: none"> <li>- milled panels on upper wings (<i>C-130</i>)</li> <li>- corner fittings and misc. areas in fuel tank (<i>C-130</i>)</li> </ul>

<sup>[1]</sup> **Note:** Specialty coatings refers to adhesives, binders, resins, and primers

# Baseline Analysis Confirmations

- Process Related:

- Process Control

- Generalized TOs or weapon system-specific process orders (AF)
- Corrosion control manuals (Navy)

- Sealant Removal Rates

- F-15 (using PMB): Range between 0.33 ft<sup>2</sup>/min. to 1.0 ft<sup>2</sup>/min
- F-16 (using scraper): Up to 2.0 ft<sup>2</sup>/hour
- C-130 (using chemical softener and scraper): Up to 4 ft<sup>2</sup>/hr for sealant and primer removal from sloping longerons

- Common Process Related Problems:

- Potential substrate damage due to scrapers;
- Accessibility to structures (IML);
- Time consuming, slow removal rates;
- Clean-up requirements;
- Awkward design of power scrapers/sanders and other ergonomic factors;
- Containment for softeners/stripped sealants; and
- Fuel leakage due to degraded or improperly applied sealant



# Baseline Analysis Confirmation Cont'd.

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- **Materials Related:**

- Good chemical removers with MIL-SPEC or NSN are required.
- Need a single application of the remover and a rapid removal rate, with minimal mechanical agitation.
- ***Polysulfide is the most common sealant used on multiple weapon systems.*** Fewer weapon systems use the urethane and polythioether sealants.
- A family of generic specialty coatings (i.e., adhesives, resins, primers, epoxies, etc...) found on all military aircraft.



# Baseline Analysis Confirmation Cont'd.

- ESOH Related:

- Personal protective equipment (PPE), explosiveness, ventilation, ease of application and disposal, as well as material containment, handling and disposal.



RAAF Maintenance workers cleaning residual sealant from the wing of an F111 after completion of resealing and replacement of the top of the wing.

**Residual  
Sealant or  
Coating  
Overspray  
Cleanup**

# Requirements Analysis - Confirmation

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- Identification of vendors
  - Stakeholders, UDRI, Army, technical bulletins, literature
- Submitted draft requirements definition document
  - Defined baseline information
  - Outlined vendor expectations
  - Defined performance and functionality requirements for compliant chemical sealant/coating removers
  - Requested vendor feedback and participation
    - Level 1 – Project commitment (October 2, 2006)
    - Level 2 – Discussions and re-issuance of requirements document (October 3 - 6, 2006)
    - Level 3 – Identify and validate candidate remover performance (October 2 - 25, 2006)
    - Level 4 – Submittal of product MSDSs (October 25, 2006)

# Product Evaluation Process Assignments

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- Vendor/Product identification (*Battelle*)
- Pre-screening validation tests (*Vendors and Battelle*)
- Product down-selection (*Air Force, UDRI, Battelle*)
- Laboratory performance testing of five down selected candidate products (*UDRI and SMI*)
- Final product down-selection (*Air Force, UDRI, Battelle*)
- Demonstration/Validation tests (*Air Force, Navy, Battelle, UDRI*)
- Draft product NSNs (*Vendors*)
- Validate acceptance criteria -T.Os, P.Os, and WS maintenance manuals (*Battelle and UDRI*)

# Vendor Identification

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- ACTech (Mr. Jonathan Zook)
- Aerochem, Incorporated (Mr. Chris Hensley)
- B&B Tritech (Mr. Robert Brock)
- Chemetall Oakite (Mr. Michael Lissandrello)
- Flamemaster Corporation (Mr. Ken Chenard)
- Franmar Chemical (Mr. Dan Brown)
- Henkel Corporation (Mr. Blake Confer)
- PPG Aerospace (Mr. Pierce Newman)
- RPM Technology, LLC. (Mr. Jim Esposito)
- SkyKleen (Mr. David McCollum)

# Prescreening Test Participants

## - Vendor/Product Identification

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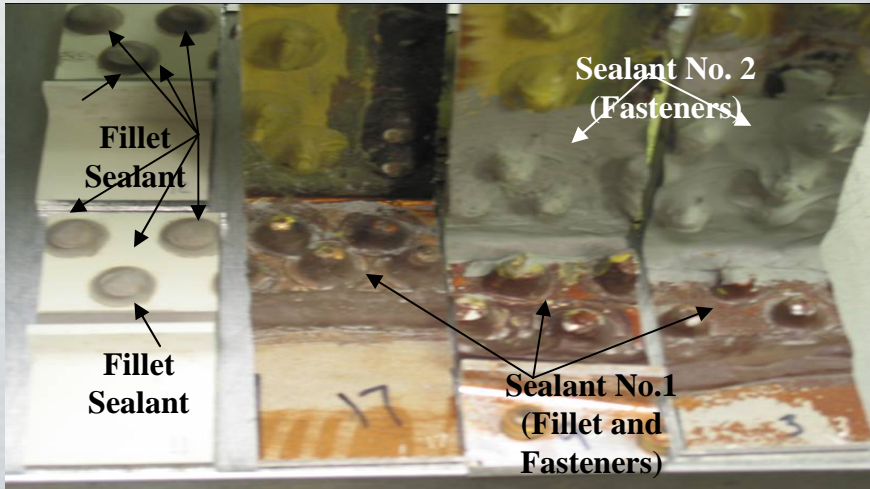
- Aerochem, Plane Naked 1-1-8
- B&B Tritech, B&B 5065 and B&B 5151B
- Chemetall, Naftosolv NC
- Flamemaster, Multiple products
- Franmar, SoyStrip
- PPG Aerospace, SR-125 and SR-145
- RPM Technology, PolyGone 300AG
- SkyKleen, SkyKleen 2000

# Vendor Down-selection Process

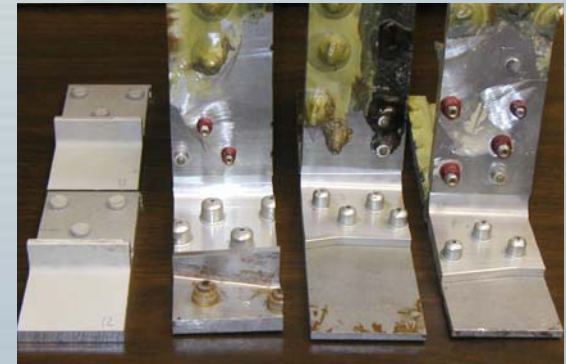
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- All participating vendors provided a post-test data sheet and video summarizing materials and processes used to remove all sealant materials from individual test panels.
- Battelle designed a prescreening score sheet that numerically ranked the following requirements:
  - Functional Requirements (Environmental acceptability and health & safety characteristics)
  - Performance Requirements (Production throughput, removal rate and efficiency, damage assessment, and inspection)
- All committee members inspected surfaces of parts, reviewed data summaries and viewed videos

# Vendor Down-selection Process



**Typical Test Coupons  
Sent to Vendors**



**Passed**



**Failed**

# Pre-Screening Results and Vendor Down-selection

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- Aerochem, Plane Naked 1-1-8
  - Excellent removal of all sealants on panels
  - Not downselected based on compatibility problems with composites (UDRI)
- B&B Tritech, B&B 5065 and B&B 5151B
  - Unable to meet deadline
- Chemetall, Naftosolv NC
  - Sample results delayed due to export control issues, reintroduced to the project May, 2007
- Flamemaster, Multiple products
  - Unable to remove sealants
- Franmar, SoyStrip
  - Removal of sealants, slow and scraper damage
- PPG Aerospace, SR-125 and SR-145
  - Unable to meet original deadline, reintroduced to the project May, 2007
- RPM Technology, PolyGone 300AG
  - Excellent removal of all sealants on panels
  - ***Downselected material***
- SkyKleen, SkyKleen 2000
  - Excellent removal of all sealants on panels
  - ***Downselected material***



# G-9 Committee Conference

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- Chemetall Naftosolv NC, PPG Aerospace, SR-125 and SR-145 reintroduced to project for pre-screening down-select
  - Chemetall export control hurdle overcome
  - PPG Aerospace also given consideration
- Products to be pre-screened in mid-May at request of AFRL/MLSC Project Sponsor (Al Fletcher)

# Ongoing Activities

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- Draft Dem/Val Plan submitted for review (3/2007)
- Down-selected vendors have provided UDRI with remover materials to complete validation tests
  - Chemetall, PPG pre-screening down-selection to occur mid-May
- Validation testing is ongoing at UDRI
  - Multiple types of sealants and specialty coatings
  - Controlled comparative testing process and analysis
  - Define optimal application and processing methods for Dem/Val of down-selected remover materials

# Ongoing Activities (cont.)

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- Validation Testing Criteria

- A definition of the amount of sealant/specialty coating that must be removed from the respective aircraft structures (i.e., define how good is good or removal acceptance limits)
- The most effective method for applying and removing the sealant and specialty coatings being investigated in support of this project
- Maximum efficiency or rate of removal for varying degrees of thickness for the polysulfide, polythioether and silicon-based sealants
- An acceptable amount of remover, number of applications, and level of mechanical agitation required to adequately remove sealant
- Acceptable post-strip clean-up requirements



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## Questions & Discussions

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